

APPLIED COMPUTING, MATHEMATICS AND STATISTICS GROUP

Division of Applied Management and Computing

A Decision Support System for Determining Newspaper Press Layout Configurations

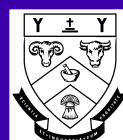
Joe Prachuabmoh, Clare Churcher and Alan McKinnon

Research Report No: 00/04
December 2000

ISSN 1174-6696

RESEARCH REPORT

LINCOLN
UNIVERSITY
Te Whare Wānaka O Aoraki



Applied Computing, Mathematics and Statistics

The Applied Computing, Mathematics and Statistics Group (ACMS) comprises staff of the Applied Management and Computing Division at Lincoln University whose research and teaching interests are in computing and quantitative disciplines. Previously this group was the academic section of the Centre for Computing and Biometrics at Lincoln University.

The group teaches subjects leading to a Bachelor of Applied Computing degree and a computing major in the Bachelor of Commerce and Management. In addition, it contributes computing, statistics and mathematics subjects to a wide range of other Lincoln University degrees. In particular students can take a computing and mathematics major in the BSc.

The ACMS group is strongly involved in postgraduate teaching leading to honours, masters and PhD degrees. Research interests are in modelling and simulation, applied statistics, end user computing, computer assisted learning, aspects of computer networking, geometric modelling and visualisation.

Research Reports

Every paper appearing in this series has undergone editorial review within the ACMS group. The editorial panel is selected by an editor who is appointed by the Chair of the Applied Management and Computing Division Research Committee.

The views expressed in this paper are not necessarily the same as those held by members of the editorial panel. The accuracy of the information presented in this paper is the sole responsibility of the authors.

This series is a continuation of the series "Centre for Computing and Biometrics Research Report" ISSN 1173-8405.

Copyright

Copyright remains with the authors. Unless otherwise stated permission to copy for research or teaching purposes is granted on the condition that the authors and the series are given due acknowledgement. Reproduction in any form for purposes other than research or teaching is forbidden unless prior written permission has been obtained from the authors.

Correspondence

This paper represents work to date and may not necessarily form the basis for the authors' final conclusions relating to this topic. It is likely, however, that the paper will appear in some form in a journal or in conference proceedings in the near future. The authors would be pleased to receive correspondence in connection with any of the issues raised in this paper. Please contact the authors either by email or by writing to the address below.

Any correspondence concerning the series should be sent to:

The Editor
Applied Computing, Mathematics and Statistics Group
Applied Management and Computing Division
PO Box 84
Lincoln University
Canterbury
NEW ZEALAND

Email: computing@lincoln.ac.nz

A Decision Support System for Determining Newspaper Press Layout Configurations

Joe Prachuabmoh, Clare Churcher, Alan McKinnon

*Applied Computing, Mathematics and Statistics Group
Applied Management and Computing Division
Lincoln University
Canterbury
New Zealand*

Abstract

In recent years, the demand for colour in newspaper production has increased considerably as newspaper readers and advertisers expect more extensive use of colour in the illustration of papers. A newspaper printing press consists of many different physical components. The way that these are set up, a *newspaper press layout configuration*, determines the attributes of the newspaper: paper size, number of sections, section sizes, and the position of colour pages. The number of possible newspaper press layout configurations is very large and to determine a press layout configuration to match a specific newspaper requirement is a very complex procedure. This report summarises how the newspaper layout configuration affects the attributes of a newspaper and describes two applications *Threading* and *Layout*, which have been developed as decision support tools to generate all possible newspaper layout configurations.

1. Introduction

Advertising staff at a newspaper need to be able to find out which combinations of *newspaper attributes* are possible, e.g. number and size of sections, number of pages and position of full or spot colour pages. Typically a printing press has several different types of printing units and not all are capable of producing colour pages. Knowing the possibilities is essential information for booking and placing advertising.

In a typical press system, the number of ways to set up the physical components i.e. the possible *newspaper press layout configurations* is very large. For example at the Christchurch Press Company Ltd., if a four-section newspaper is required, there are approximately one hundred and sixty different options, resulting in newspapers ranging from thirty-two pages to one hundred and four pages with various options for the placement of colour. Currently, the company maintains a book of *known good* press layout configurations. This shows different ways that the press components can be set up and what the attributes of the resulting newspaper would be.

As the final printing deadline approaches, newspaper requirements may change, requiring the advertising staff to consider a different configuration. If an appropriate one does not already exist in the book of *known good* solutions then determining a new configuration in a short period of time can be difficult and frustrating. In addition, mechanical failures may necessitate finding a new configuration. This can place considerable pressure on the few expert staff capable of generating press configurations to find an alternative solution. Another problem is the determination of newspaper layout configurations when an expansion of the press equipment is being planned.

There are a number of physical constraints on the way the press components can be set up, which means that it may not always be possible to generate a newspaper with particular attributes. It would be extremely helpful if all valid press configurations could be determined so that decisions about meeting requirements could be made effectively and quickly. This information is not readily available at present.

There is very little information about other computerised systems attempting to solve this problem. Two applications were found: ColourFall™ (*Stainer, 1998*) and Press Builder™ with Plate Imposition™ (*PTI Inc., 1998*). These systems either aid users to choose from already recorded configurations or allow users to enter possible configurations and check their validity. We were unable to find any systems that could generate a complete set of configurations given the physical constraints of the press system.

1.1. Proposed system

There is clearly a place for a system that can rapidly derive all possible newspaper press layout configurations consistent with the physical constraints of a given printing press. With such a system, all the possible different newspapers (pages, section size, etc.) would be readily available, and staff would not be limited to choosing from those discovered manually.

The specific printing press system, which was investigated for this project, was at the Christchurch Press Company Ltd. However, the decision support system developed is quite general. The system was designed and developed so that it could be easily adapted for any printing press system, which uses web printing. The only input required is a description of the printing units and physical constraints, which determine the possible paths of the webs of paper.

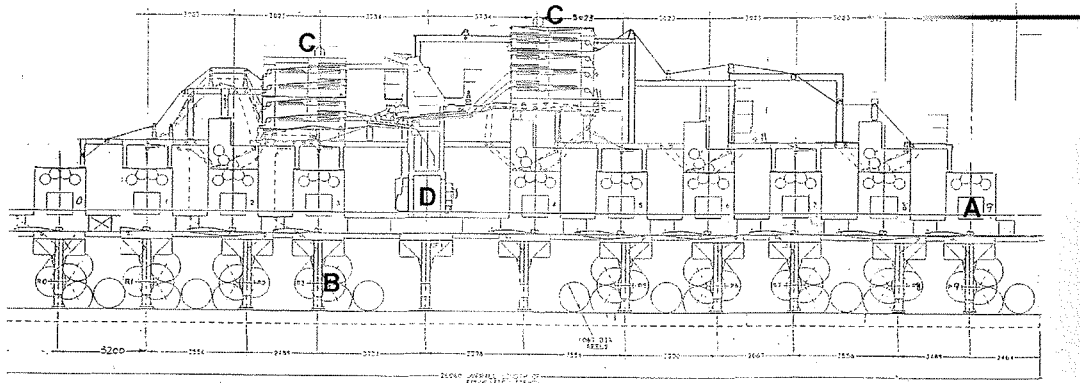
2. Overview of a newspaper printing press system

This section summarises the major components and processes that affect the newspaper press layout configuration in a press system. For a more complete description of the processes see Prachuabmoh (1999).

There are three major components:

- printing units
- trolley bar stacks
- and folders.

The arrangement of the components may vary among different press manufacturers, but the processes and sequences are similar.



Source: Gerald Nally, Christchurch Press Company Limited

Figure 2.1 A technical drawing of the printing press system at the Christchurch Press

Using the Christchurch Press as an example, the components and processes which contribute to a newspaper production, can be described as follows: (refer to Figure 2.1).

- There are ten printing units (A) arranged one after the other. The different types of these printing units are described in Section 2.1.
- Webs of paper are fed from rolls (B) under the press room level. Each web passes through one or more printing units. The possible paths for a web are restricted by the physical construction of the press. In addition, the number of webs and their widths can be varied depending on the required size of the newspaper.
- When a web comes out of the printing units, it passes to the trolley bar (C) where it may be slit into ribbons. Ribbons from each of the trolley bars are then stacked and aligned.
- Finally, the ribbons are guided to be folded into a completed newspaper at the folder (D).

2.1. Printing units

Printing units are made up of plate cylinders upon which the printing plates for each page are laid. At the Press four plates (pages) can be laid along the length of each cylinder and each cylinder has two sides. I.e. in one completed revolution of the cylinder eight pages can be printed.

There are two types of offset printing units at the Christchurch Press.

- The blanket to blanket unit type (Type-A) which has two plate cylinders
- The semi-drum unit type (Type-B) which has three plate cylinders.

The 6 Type A and 4 Type B printing units at the Christchurch Press are arranged as shown in Figure 2.2.

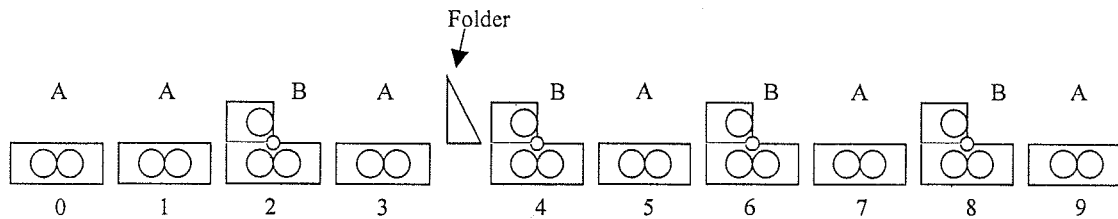


Figure 2.2 Printing Units at the Christchurch Press

The web may pass through more than one printing unit provided that there is no physical obstruction between units. The different paths that a web can take affects the number of colours that can be printed on each side of a web.

There are four types of path that can apply different colour combinations to the web.

Type I path

One roller is applied to each side of the web: (Needs one Type-A or Type-B unit). This results in black-and-white (or one colour) newspaper pages on both sides of the web. This is shown in Figure 2.3.

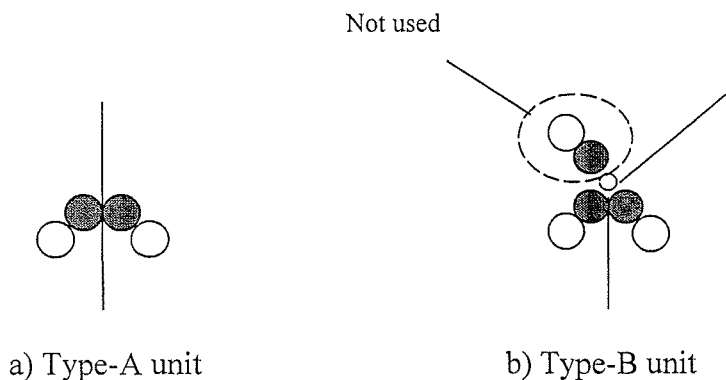


Figure 2.3 Type I Path

Type II Path

One roller is applied to one side and two rollers to the other: (Needs at least one Type B unit). This results in black-and-white pages on one side, and black-and-white plus a single colour (called a spot-colour page) on the other side of the web.

Type III Path

One roller is applied to one side and four to the other. (Needs one each of Type A and B units). The combination of these two unit types, as illustrated in Figure 2.4, results in full-colour pages being printed on one side of the web, and black-and-white pages on the other side.

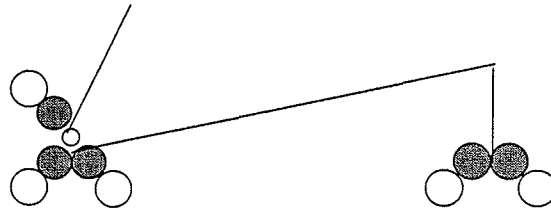


Figure 2.4 Type-III path

Type IV Path

Four rollers are applied to each side of the web: (Needs two each of type A and B units). This results in full-colour newspaper pages being printed on both sides of the web.

The combination of different webs using different types of paths offers a variety of colours (black-and-white, spot-colour, full-colour) pages in a newspaper. There are constraints imposed by the physical press construction that limit the web's passage between printing units.

The valid paths constitute one of the sets of base data that needs to be input to describe the physical press. This is described in more detail in Prachuabmoh (1999).

2.2. Printing modes

Each plate cylinder has two sides (H and L). This allows the press system to operate in two modes.

Collective mode –

Different page plates are strapped to the H side and the L side of the plate cylinder. One completed newspaper includes pages printed from both the H and L sides of the cylinder.

Straight mode –

The same set of newspaper plates is affixed to both the H and L side of a plate cylinder. This means that two copies of a completed newspaper are produced for each revolution of the plate cylinders.

2.3. Folding mechanisms

After the webs emerge from the different printing units, they are collated, folded, and cut into a completed newspaper. The components involved are:

- Slitting devices
- Formers
- Angle bars
- Folding couple (Cut-off and collective cylinder).

2.3.1. Slitting devices

This device is used to slit the web into ribbons of the required width. The webs that travel through the printing units can have four sizes: full, three-quarter, half, and quarter width. These webs can produce: sixteen (four printing plates across on H and L side on both sides of the web), twelve, eight, and four newspaper pages, respectively.

After the web runs through the printing unit(s), it is guided to a trolley bar where the web is slit into ribbons, normally the width of one or two plates.

2.3.2. Formers

After the ribbons emerge from the trolley bar, they are aligned and folded with ribbons from the same or different printing unit(s), and guided to a former which folds the webs longwise into what will become the sections of the paper. At the Christchurch Press there are four formers which means that newspapers of up to eight sections can be produced in collective mode, and papers of up to four sections in straight mode.

2.3.3. Angle bars

The angle bars are used to direct the ribbons from the trolley bar to different formers in the press system. This alters the sizes and number of sections in a delivered newspaper. Two angle bars can be used to flip a particular ribbon before it is guided to a former. This setting is referred to by printing experts as a *bay window setting*. This provides more choice in the sequence of colour pages.

2.3.4. Folding Couple

The folding couple is where the folded ribbons from different formers are collated to form a complete newspaper. In general, additional components at the folding couple allow for the folding and cutting of ribbons into different sizes, such as a tabloid (a half of newspaper size), and a magazine (a quarter of newspaper size). The components that perform such tasks have not been included in this analysis.

2.4. The press configuration sheet

Each day a press configuration sheet (Figure 2.5) is created (or selected from existing ones) to describe the press setting for the day's paper. The information on the sheet includes:

- **Newspaper attributes and layout details:** In the example in Figure 2.5, the paper has thirty-six pages, four sections, and section sizes of 10-8-10-8 (C). This production is in collective mode, as the plates on the H and L sides of each plate cylinder are different.
- **The number of webs used:** Figure 2.5 depicts three webs which are fed through units 3-2, (D1) 5-4 (D2), and 7-6 (D3).
- **The webs' sizes:** The width (size) of the web passing through the printing units can be seen by the number of plates on each of the units. In this example, a half, full, and three-quarter-sized web pass through unit 3-2 (D1), 5-4 (D2), and 7-6 (D3) respectively.
- **The arrangement of page printing plates:** Once the sequence of pages has been established, then the position of the different types of colour pages can be determined by noting the number of colours that are to be printed on the side of the web on which the page's plate is laid. As an example consider the web starting at Unit 7 in Figure 2.5a. It can be seen that page numbers 8, 13, 16, and 26 are printed four times, thus each will be a full-colour page.

A half size web is fed through unit 3 and 2 (D₁)

GOSS METRO

PAGES	SECTIONS	MAKE-UP
36	4	10/8

2
4
6

Layout details (C)

Issue: Monday March 16

Sections: 4

Colour Deck 2: Four colour P. 3, 6, 21, 24

Colour Deck 3: Process blue P. 6

Colour Deck 4: Red (m/y) P. 21

Colour Deck 5: Four colour P. 1, 10, 11, 18, 19, 28, 29, 36

Colour Deck 6: Process blue P. 36

Colour Deck 7: Red (m/y) P. 19, 28, 29, 36

Colour Deck 8: Three colour P. 10

Colour Deck 9: 35 green P. 10

A full size web is fed through units 5 and 4 (D₂)

A three quarters-size web is fed through unit 7 and 6 (D₃)

Each big rectangle represents a plate cylinder and each small rectangle represents a plate in a unit from the top view

Type-B unit (A₂)

Type-A unit (A₁)

A unit number

A colour is put on each roller. No colour means black colour being applied

These represent the formers where the webs are folded lengthwise. There are actually four formers in the system, but only two lower formers are shown. (B).

Figure 2.5a Example of a press configuration sheet

2.5. Effects of the components on the newspaper attributes

A summary of the different components and how they affect the attributes of the newspaper is shown in Figure 2.6. While the principles discussed in this section are quite general, the specific examples are based on the system at the Christchurch Press. The findings can be applied to other printing sites with similar characteristics.

Settings	Consequences in a paper
Number of webs used and their width	Number of pages
Webs' path through units	Number of colour pages
Number of formers used	Number of sections
Run mode	Number of sections and number of coloured pages
Position of non-full sized web including how webs are slitted into ribbons on trolley bar	Size of sections
Angle bars	Size of sections
Former setting	Order of sections
Printing plates	Order of pages, and colours layout
Bay window setting	Colour layout

Figure 2.6 Factors affecting newspaper attributes

3. Required tasks

It is important to understand the tasks that different users of the system undertake during a production run.

3.1. Characterisation of the users

In order to capture the requirements from different points of view, the staff involved in a production run were categorised into two different groups depending on their involvement with the newspaper press configurations.

1. **Editorial** – the editorial staff are those users who are mainly interested in *newspaper attributes* such as: paper size, number of sections, section sizes, the numbers and position of differently coloured pages. The group includes advertising personnel, layout coordinators, editors, and management people. For instance, they may determine that a forty-eight page, three-section paper is

required. They may then wish to know the possible section sizes, and the possible positions of full-colour pages for such a newspaper.

2. **Printers** – the printers are those members of staff who can provide the possible press layout configurations. They are mostly concerned about the component settings of the press system used in a production run. These include how a web is threaded, the sizes of the webs, angle bar settings, former settings, and the arrangement of printing plates on the printing units.

3.2. Normal routines in a production run

In a typical day, editorial staff select a newspaper press layout configuration from the folder of *known good* press layout configurations. They choose a configuration which will satisfy their requirements in terms of newspaper attributes. Later the layout configuration will be used by printers to set up the press components appropriately for the production run.

Sometimes the editorial staff require attributes (size, layout etc) in a newspaper that are not catered for by the *known good* configurations. The editorial staff then need to consult with the printers on the possibility of producing a new configuration. If the printers can find an acceptable solution, the new press configuration would be added to the folder.

These steps in a production run can be summarised as follows:

1. The particular newspaper-size attributes are chosen from the possibilities in the *known good* press layout configuration folder.
2. The colour layout, which can be altered within a particular newspaper size, is selected. The colour layout is also chosen from the *known good* folder.
3. If the desired values of newspaper attributes are not in the *known good* folder, the printers will be asked to determine a new press layout configuration. However, this may not always be easy or even possible. At the moment, it is always unclear whether this is because no such configuration exists, or whether the printers have not yet been able to determine the appropriate combination of components. If a new configuration is found then it is added into the *known good* folder.
4. A specific press layout configuration is selected for the production run.
5. The press components are set up according to the specified configuration.

3.3. Overview of the tasks in the proposed system

These are summarised in the use case diagram in Figure 3.1. The diversity of the newspaper attributes depends very much on the press resources such as printing units, and folding mechanisms. This implies if there are changes to the physical resources, the possible newspaper attributes will be affected. It is important that an alteration in resources does not necessitate re-writing the proposed system. To guard against this, a description of the resources is supplied as *base data*. The base data will be stored in data files and only these need to be changed when resources are modified.

Following this the staff can choose a *threading*. We define the *threading* as the number of webs of paper used in a production run and the paths that they take through the printing units. In practice, only a few *threadings* are ever used at the Christchurch Press. There are two threadings that are regularly used which maximise the number of colour

pages, and a few others (about five) which compromise the number of colour pages to produce a larger paper. Within these threadings, there is a huge variation in the settings of other components that can provide many different newspaper attributes. Different threadings do not necessarily provide new newspaper configurations but often merely reproduce existing ones. On rare occasions, a new *threading* may need to be constructed to avoid units under repair.

As there are a very large number of possible threadings, it was decided that the proposed system would not generate them all. Instead, the software assists the printers in defining possible new threadings on the rare occasions that this may be necessary, for example in the case of mechanical failure of one of the printing components.

For a particular defined *threading*, the proposed system will then be able to deduce all the possible newspaper press layout configurations

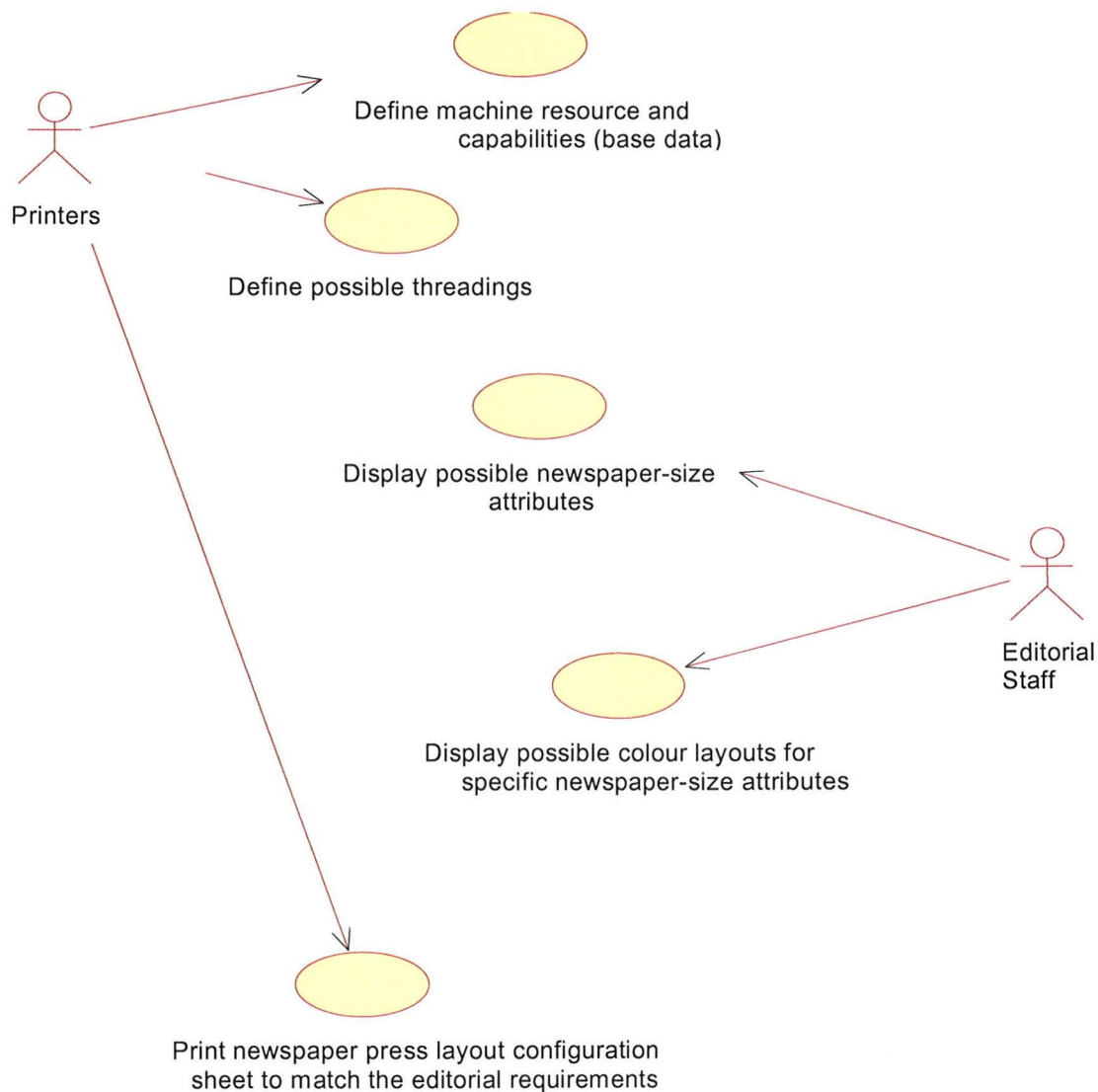


Figure 3.1 Main tasks for the proposed system

4. The resulting decision support system

Microsoft Visual Basic version 5.0™ (VB) was used to develop the system which has been implemented as two major applications: *Threading* and *Layout*. In this section we show the resulting system in terms of the user interface and describe how it will be incorporated into the current activities at the Christchurch Press. Details of the design of the systems and discussion of the implementation issues can be found in Prachuabmoh (1999).

The purpose of the *Threading* application is to allow the users (mostly printing staff in this case) to define valid threadings for use in a production run. As described, only a few threadings are ever actually used in practice and they are usually chosen to maximise the paper size, or the number of colour pages. Although its output is critical, it is not envisaged that this application will be used very often. The *Threading* application relies on the base data that describes the physical resources of the printing press. Should these resources change new threadings will need to be defined.

The *Layout* application, will be used frequently (probably daily) to determine possible newspaper attributes and their corresponding newspaper press layout configurations. It uses the threadings defined by the *Threading* application as part of its input.

4.1. Threading application

The *Threading* application provides a user interface for printers to select elementary paths to build up legal routes that a web can take through the printing units. These threadings can then be saved and used later by the *Layout* application.

The information is presented in a way that the user finds intuitive and follows a logic that the user is familiar with. Initial user feedback has been positive but further work is possible to evaluate different approaches and how this would affect the time taken to learn and use the system.

The screen presented to the user is shown in Figure 4.1. The layout of the printing units is represented using a side view of the actual system. Each of the printing cylinders is depicted by a circle containing its identification number. The list boxes display the possible paths that each web can take. The user is able to make a choice from these possible paths at each step.

The colouring of the cylinders was chosen to help the user see easily the route each web takes and also which cylinders are contacting each side. Each web is assigned a different colour depending on the unit it started at and the cylinders it passes are then given that colour. The fill type of the cylinders informs the user which side of the web is being contacted. Cylinders depicted with a solid colour fill are those contacting the rear side of a web. Cylinders depicted with a cross-hatched fill are those contacting the front side of a web.

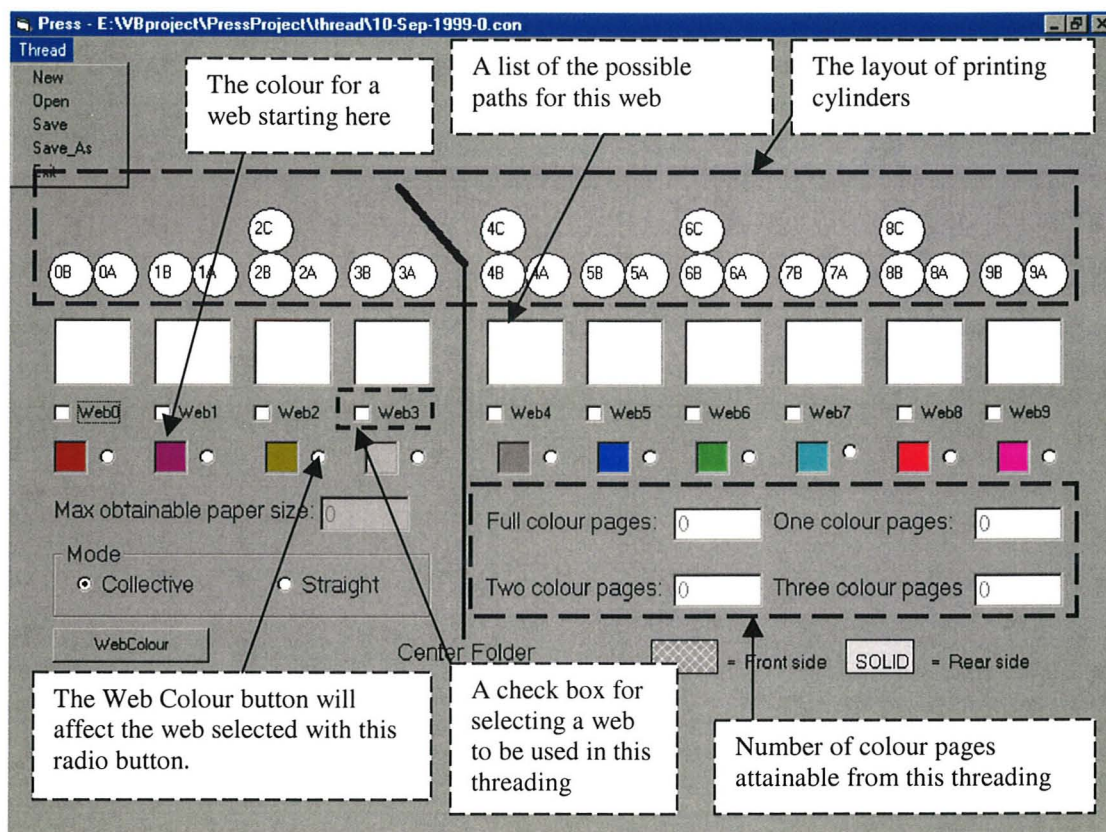


Figure 4.1 Threading interface before any paths are selected

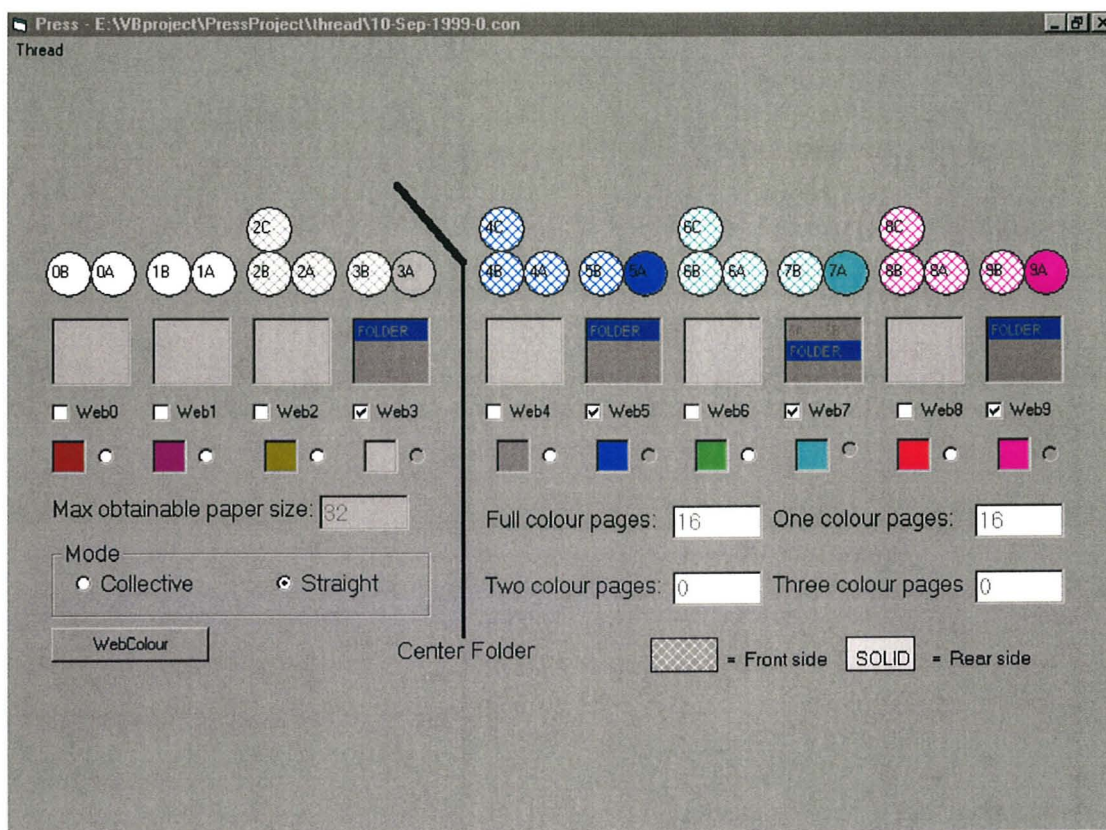


Figure 4.2 Threading interface with four webs defined

4.2. Layout application

With the threadings defined, it is now possible to consider all the other settings (angle bars, trolley bars, web sizes, web positions, former settings) that affect the newspaper attributes.

The following is a summary of the steps in the order that they are presented to the user using the *Layout* application. The *Layout* application enables the user to discover all the possible newspaper configurations from a particular *threading*. Once a specific *threading* is chosen, the application provides information to assist users to make decisions about the possible newspaper attributes. As decisions are made, the information at each step becomes more specific.

The steps for using the *Layout* application can be summarised as follows:

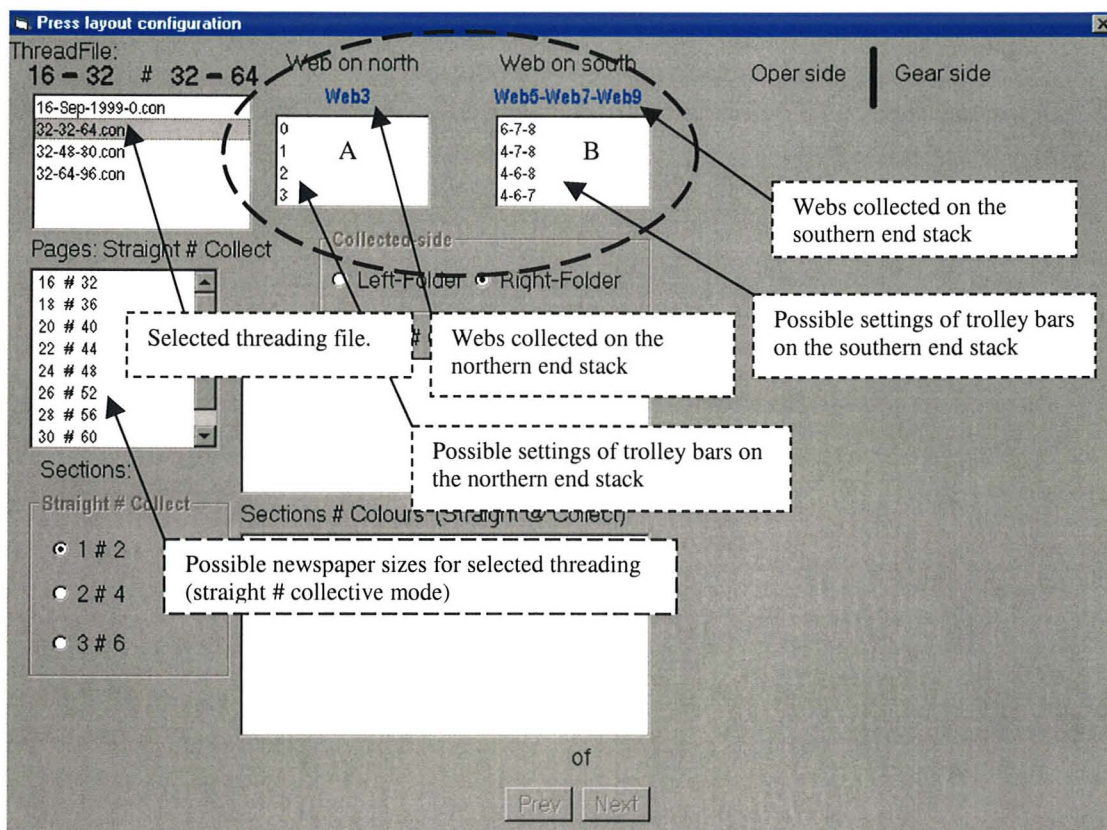


Figure 4.3 Step 1: display valid threadings and Step 2: display valid newspaper size

Step 1.(Figure 4.3) Display valid press threadings that have been generated from the *Threading* application. Display the webs which will arrive at each trolley bar stack and show the possible trolley bar and slitter settings (see section 2.3.1).

User's action: select a *threading* and trolley bar setting.

Step 2.(Figure 4.3) Provide choices of valid numbers of newspaper pages that can be produced from the *threading* when the press runs using either straight or collective mode.

User's action: select the number of pages required for a newspaper.

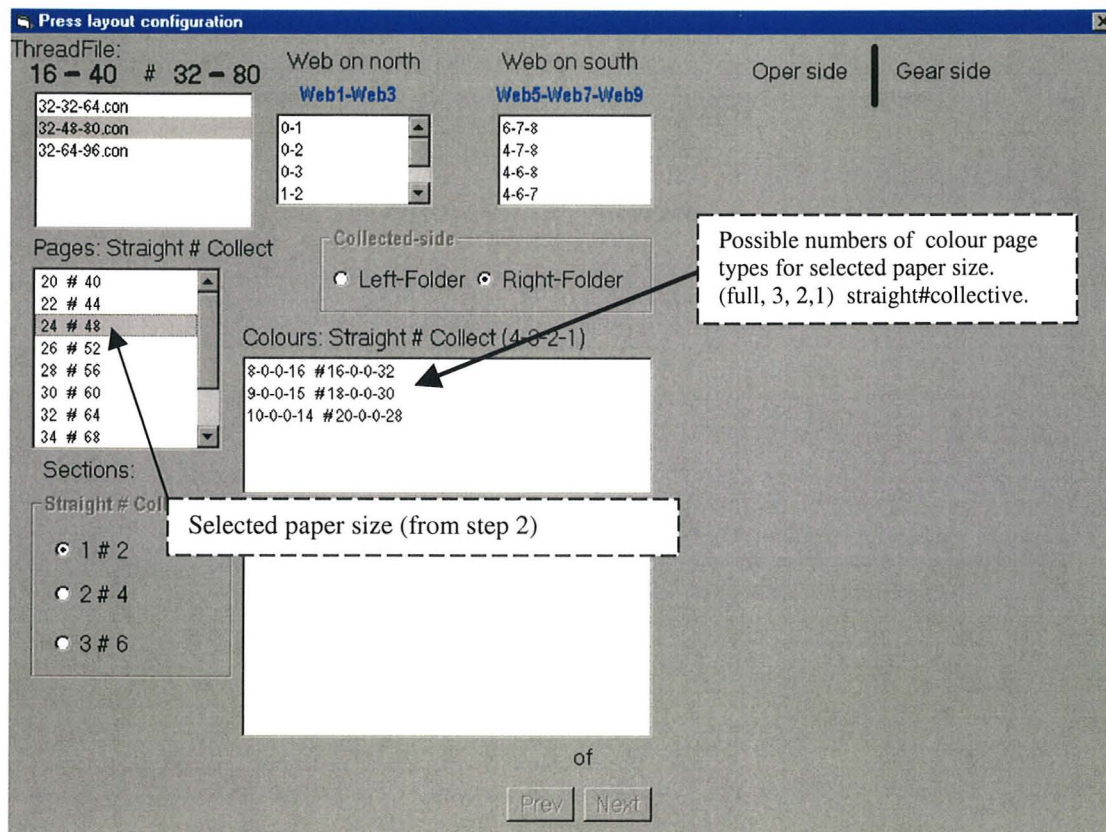


Figure 4.4 Step 3: display possible numbers of colours pages

Step 3.(Figure 4.4) Display possible numbers of colours pages (1, 2, 3, or full colour) for the chosen size.

User's action: select the number of colour pages that are required.

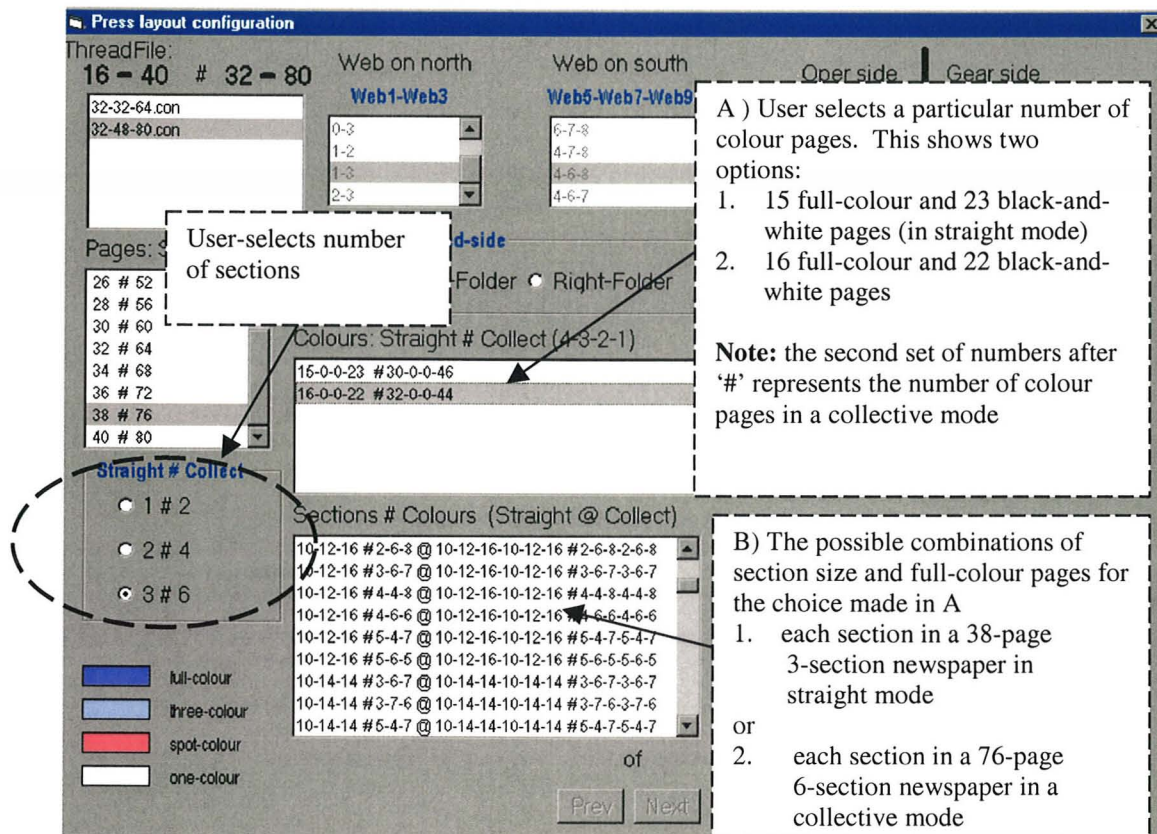


Figure 4.5 Step 4: Provide a combination of section sizes and the number of colours pages in each section that can be generated for the newspaper.

Step 4.(Figure 4.5) Provide a combination of section sizes and the number of colour pages in each section that can be generated for the newspaper. The number of sections can be altered as users work through step 3 and step 4. In the case of a one or three-section paper in straight mode (two or six section in collective mode), the user is able to choose which former(s) are to be used. For a two-section paper in straight mode (four-sections in collective mode), a default value for the former setting is applied.

User's action: select a combination that suits the newspaper requirements.

Step 5.(Figure 4.6) Display all possible valid page configurations consistent with the user input from each of the previous steps. The configuration information includes:

- 1) The layout of colour pages in the newspaper
- 2) The size of webs used on a unit(s) (half, three-quarter, or full-size)
- 3) The position of the webs on the unit(s) if a non-full size web is used
- 4) The setting of turner bars applied to each web
- 5) The plate position on the plate cylinders for each unit(s) that a web passes

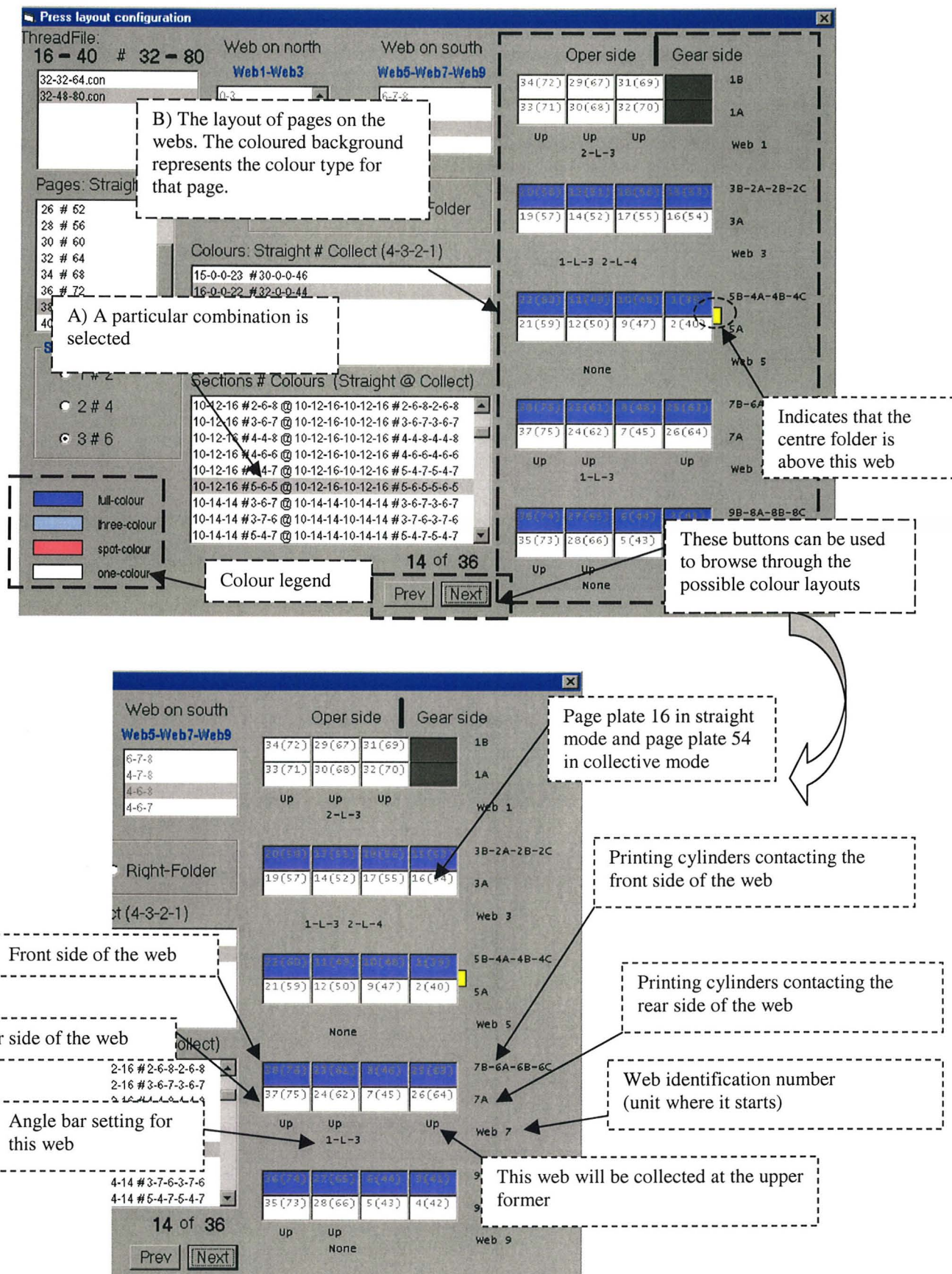


Figure 4.6 Step 5: display colour layout and corresponding press configuration

The information shown in Figure 4.6 is sufficient for a printer to be able to set up the components of the press in order to achieve the chosen newspaper attributes.

It shows:

- The size and position of each web
- The units that each web passes
- The angle bar setting for each web
- The trolley bars used by each web
- The positions of the page plates on the cylinders for straight mode and collective mode.

For particular newspaper size attributes, there may be many different possible colour layouts. The users are able to browse through the different possibilities by clicking the **Prev Next** buttons in Figure 4.6.

In some cases the same colour layout may be possible from different press layout configurations. A further extension could be to group the layouts by page number and colour type before presenting them to the user.

User's action: Browse through the possible layout configurations and choose one to match the editorial requirements. The press configuration information is displayed simultaneously.

5. Conclusion

The objective of this project was to provide a decision support system to aid printers and editorial staff at a newspaper company such as the Christchurch Press to determine how best to meet the colour requirements for daily newspaper production.

This objective has been met by the applications *Threading* and *Layout*. Together they provide a tool to produce information about the different possible newspaper attributes in a manageable way.

The main advantage over existing systems is that all possible newspaper press configurations are able to be generated in a particular *threading*. Previous systems rely on choosing from manually produced *known good* solutions. This is clearly unsatisfactory for new editorial requirements and also for the case when equipment breakdowns require novel solutions.

The first versions of the applications have been successfully tested by staff at the Christchurch Press. They have been able to generate configurations corresponding to existing *known good* solutions, and no inconsistent configurations have been generated by the system. The interface design has received general approval.

Although a number of extensions such as the inclusion of a bay window setting and the printing of a press layout configuration sheet are suggested for further development, the *Threading* and *Layout* applications are now able to be used in a production environment.

6. Acknowledgements

We would like to thank the Foundation for Research Science and Technology for their financial support through the Graduate in Industry Fellowships scheme (GRIF contract no. CPC710C).

We also wish to express our gratitude to the staff of Christchurch Press Company. Particular thanks must be given to Jim Meek – Production Manager, and Gerald Nally – Chief Engineer for their time, interest and patient explanations of the press printing system, and to Henrietta Hall for bringing this fascinating problem to our attention.

7. References

Prachuacbmoh, P. (1999) *Production Strategies for Newspaper Press Layout Configurations*